Table 2.4-2
Technology and Process Options Screening Summary
Portland Harbor Superfund Site
Portland, Oregon

General Response Action	Technology Type	Process Options	Effectiveness	Implementability	Cost	Retained?	Representative Process Option?
No Action	None	Not Applicable	The No Action response is not effective in reducing the baseline unacceptable human health and ecological risks in the Study Area (see Chapters 8 and 9 in RI Report). Does not meet RAOs.	.Technically implementable site-wide	None	Yes	Yes
Institutional Controls	Governmental Controls	Commercial Fishing Bans	Limited to contaminants that accumulate in fish or shellfish. Mainly for commercial fisheries; not very effective for recreational fisheries. Ineffective for limiting ecological exposures. More effective if used in conjunction with more active technologies.	Requires commitment and cooperation of implementing party to administer and acceptance of Native American tribes and public.	Low	Yes. As a component of alternatives that also include active measures.	No
Institutional Controls	Governmental Controls	Waterway Use Restrictions or Regulated Navigation Areas	Enforcement of restrictions in a large waterway is difficult, especially for recreational boaters. Typically used in conjunction with active remedial technologies such as capping, dredging and capping, EMNR and in-situ treatment to enhance long-term effectiveness.	Requires commitment and cooperation of implementing party to administer and acceptance of Native American tribes and public. Dredging and navigation restrictions would be limited due to extensive navigational use of waterway.	Low	Yes. As a component of alternatives that also include active measures.	Yes
Institutional Controls	Proprietary Controls	Land Use/Access Restrictions	Better for controlling human exposures than ecological exposures. Not effective for ecological exposures. More effective if used in conjunction with more active technologies.	Requires commitment and cooperation of impmenting party to administer and acceptance of Native American tribes and public.	Low	Yes. As a component of alternatives that also include active measures.	Yes
Institutional Controls	Proprietary Controls	Structure Maintenance Agreements	Enhances effectiveness of capping based remedies by requiring maintenance of co-located structures.	Requires commitment and cooperation of impmenting party to administer and acceptance of Native American tribes and public.	Low	Yes. As a component of alternatives that also include active measures.	No
Institutional Controls	Informational Devices	Isolation Barriers	Enforcement of restrictions in a large waterway is difficult. Typically used in conjunction with active remedial technologies such as capping, EMNR and in-situ treatment to enhance long-term effectiveness in river bank areas.	Requires commitment and cooperation of implementing party to administer and acceptance of Native American tribes and public.	Low	Yes. As a component of alternatives that also include active measures.	No
Institutional Controls	Informational Devices	Fish Consumption Advisories	Limited to contaminants that accumulate in fish or shellfish. Mainly for commercial fisheries, not very effective for recreational fisheries. Better for controlling human exposures than ecological exposures. More effective if used in conjunction with more active technologies.	Requires commitment and cooperation of implementing party to administer and acceptance of Native American tribes and public.	Low	Yes. As a component of alternatives that also include active measures.	Yes
Monitored Natural Recovery	Physical Transport	Desorption, dispersion, diffusion, dilution, volatilization, resuspension, and transport.	Physical transport generally increases exposure to contaminants and may result in unacceptable risks to downstream areas or other receiving water bodies.	MNR works best where the source of pollution has been removed. Need to identify if these processes are occurring to a degree likely to result in reduced risk to receptors.	Low	Yes. As a component of alternatives that also include active measures.	No
Monitored Natural Recovery	Chemical and Biological Degradation	Dechlorination (aerobic and anaerobic), biodegradation	Limited to SVOCs and PAHs. Does not result in complete degradation of PCBs and dioxins/fuans in and acceptable time frame. PCB and dioxin/furan dechlorination is not directly related to toxicity reduction. Not applicable to metals.	MNR works best where the source of pollution has been removed. Need to determin if degradation processes are occurring to a degree likely to result in reduced risk to receptors.	Low	Yes. As a component of alternatives that also include active measures.	No
Monitored Natural Recovery	Physical Burial Process	Sedimentation	Works best in depositional areas. Not effective in areas with wave, current or propwash generated erosion or subject to routine dredge maintenance. Requires demonstration of long-term deposition and burial.	MNR works best where the source of pollution has been removed. Need to identify if tdepostional processes are occurring sufficiently to reduce risk to receptors.	Low	Yes. As a component of alternatives that also include active measures.	Yes
Enhanced Monitored Natural Recovery	Enhanced Burial/Dilution	Thin Layer Cover	Applicable at areas where MNR processes are demonstrated, but faster recovery is required, or as a residual management tool after completion of removal action.	EMNR works best where the source of pollution has been removed.	Low	Yes	Yes
		Engineered Cap	Effective for low-solubility and highly sorbed contaminants (e.g., PCBs) where principal transport mechanism is resuspension/deposition. Not effective in potential scour areas from river currents or propeller wash. Not effective in controlling groundwater plumes. Long-term monitoring and maintenance would be required to ensure that a cap remained effective despite these factors. The organic carbon content of the primary capping material may provide some sorptive capacity in an engineered cap allowing the cap to both physically and chemically sequester contaminants and increase its effectiveness.	Requires flood rise analysis and must consider water use, depth requirements, and slope stability. Easily applied in situ; however, scouring must be considered. May not be implementable in navigation or berthing areas. May require mitigation if not habitat friendly. Decreased water depth may limit future uses of waterway and may impact flooding, stream bank erosion, navigation, and recreation.	Low	Yes	Yes

		Armored Cap	Armored caps are effective in reducing mobility of contaminants by isolating impacted sediments from the water column and reducing the exposure to fish and other biota but will not affect the toxicity or the volume of contaminants.Applicable at areas where increased velocities from river flow or potential scouring due to propeller wash might be expected. Not effective in controlling groundwater plumes.	Requires flood rise analysis and must consider water use, depth requirements, and slope stability. May not be implementable in navigation or berthing areas. May require mitigation if not habitat friendly. Decreased water depth may limit future uses of waterway and may impact flooding, stream bank erosion, navigation, and recreation.	Low-Moderate	Yes, for areas with high erosive forces.	Yes. For areas in main navigation channel.
	Capping	Clay Cap	Such materials can be used for maintaining slope stability. They are effective in reducing mobility of contaminants by isolating impacted sediments from the water column and reducing the exposure to fish and other biota but will not affect toxicity or volume of contaminants. Effective for scour and biointrusion protection and maintaining slope stability. Since the use of subaqueous clay caps over large areas has not been well documented, the effectiveness is unknown.	A primary concern with the use of clay caps is their long-term performance (with respect to maintaining integrity) in areas of significant groundwater upwelling or diversion. However, clay aggregate material and GCLs may be technically implementable and administratively feasible as an armor layer to protect an underlying engineered cap from erosive forces while also reducing friction in erosive areas (compared to friction anticipated to be generated using stone armor).	Moderate	Yes as potential armoring and slope stabilization material.	No
		Composite Cap (e.g., HDPE, Geotextile)	Porous geotextile cap layers do not achieve sediment isolation, but are effective in reducing the potential for mixing and displacement of the underlying sediment with the cap material. Geotextiles allow the sediments to consolidate and gain strength under the load of additional cap material. Effective in reducing cap thickness, providing additional floor-support, providing bioturbation barrier, or areas where methane generation may be issue. They are effective in reducing the mobility of contaminants by isolating impacted sediments from the water column and reducing the exposure to fish and other biota but will not affect toxicity or volume of contaminants.	Requires flood rise analysis and must consider water use, depth requirements, and slope stability. May not be implementable in navigation or berthing areas. May require mitigation if not habitat friendly. Decreased water depth may limit future uses of waterway and may impact flooding, stream bank erosion, navigation, and recreation. Implementability over large areas may be challenging.	Low-Moderate	Yes, for areas that do not otherwise have the strength to support a cap.	No
		Reactive Cap	Reactive caps are effective in reducing mobility of contaminants by isolating impacted sediments from the water column and reducing the exposure to fish and other biota but will not affect toxicity or volume of contaminants. They are specific to chemical being managed; demonstrated effectiveness for PAHs, PCBs, dioxins and furans and chlorinated pesticides. Bench scale efffectivenss for metals. May not be effective where multiple types of contaminants (e.g., metals and organics) are co-located. Reactive caps eventually lose their sorptive or chemically reactive treatment capabilities. Site monitoring would be required to determine whether the active layer should be replaced and the cap reconstructed to remain protective.	Requires flood rise analysis and must consider water use, depth requirements, and slope stability. May not be implementable in navigation or berthing areas. May require mitigation if not habitat friendly. Decreased water depth may limit future uses of waterway and may impact flooding, stream bank erosion, navigation, and recreation.	Low-Moderate	Yes	Yes. For areas with groundwater plumes
In-Situ Treatment In-Situ Treatment	Physical	Solidification/Stabilization	Effective in reducing mobility of contaminants by isolating impacted sediments from the water column and reducing the exposure to fish and other biota but will not affect the toxicity or the volume of contaminants.		Low-Moderate	Yes. Limited to areas where access and slope stability issues exist (e.g., contaminated banks behind major structures with limited access).	Yes. For limited acess areas.
		Sequestration	Limited to organic compounds and some metals. Requires site-specific studies to determine extent of use and effectiveness.	Has been demonstrated to works best with lower levels of contaminants. Easily applied in situ; may require armoring in scour areas.	Low-Moderate	Yes	Yes. For lower contaminant concentrations.
Sediment/Soil Removal		Mechanical Dredging-	Effective in removing stiffer or denser sediments, but requires greater effort to reduce resuspension rates and residual production. Residuals will require management strategies to achieve cleanup goals. More effective at handling debris. Environmental buckets suitable for softer materials with low debris; clamshell buckets suitable for harder, dense sediments.	Equipment is available. Dredge depths are limited by the ladder and cable lengths. Application in shallow water depths limited by draft of supporting barge or ship. Requires barge to place material during operations. May require contaminant barrier during dredging activities.	Moderate	Yes	Yes
Sediment/Soil Removal	Dredging						

	Dredging	Hydraulic Dredging	Effective in removing soft or loose sediments with high water content. Capable of lower resuspension rates at the point of dredging, as well as lower in-water residual production than mechanical dredging. Residuals will require management strategies to achieve cleanup goals.	The presence of large amounts of debris can adversely affect hydraulic dredging operations and may require pre-debris sweeps. Dredge depths are limited by the ladder and cable lengths. Application in shallow water depths limited by draft of supporting barge or ship. Requires close proximity (3 - 5 miles) to land-based dewatering facility, barge dewatering facility, or CDF due to pumping limitations. Slurry separation and disposal rates can be slower than dredging rates and may limit the rate of dredging. May require contaminant barrier during dredging activities. Although in some cases diver-assisted hydraulic dredging or video-monitored dredging can be used, turbidity, safety and other technological constraints typically result in dredging being performed without visual assistance. Barge transport of hydraulically dredged material is inefficient	Moderate	Yes	No
		Specialized and Small Scale Dredge Equipment	Can be conducted close to infrastructure and within tightly restricted areas. Less residuals due to higher precision from dredging operations. May be the most effective approach for precise cleanup of a hard face, since the divers can feel the surface and adjust the excavation accordingly. Vic Vac can be useful for removing residuals from hard surface.	Production rates are much less than other removal equipment mainly due to smaller size of removal equipment a diver can handle. Seldom require contaminant release controls. Barge transport of hydraulically dredged material is inefficient. Ability of divers to maintain a desired position will be hampered by currents. Presence of logs and large debris may present dangerous conditions for diver-assisted dredging. Although divers can remove sediment from around large debris or rocks, this type of operation would be inefficient. Removal is limited to thin cuts.	High	Yes. Limited to areas with infrastructure and within tightly restricted areas.	No
	Excavation	Dry Excavation	Effective where water depths limit conventional dredging equipment.	Requires installation of sheet pile walls or cofferdam, unless performed in exposed areas during low river stages. Limited application to areas that can be reached from shore or by specialty equipment designed to work on soft unconsolidated sediments. Equipment is locally commercially available.	Low-Moderate	Yes	Yes
Disposal	Commercial Landfill	Hillsboro	Most effective for materials with the lowest potential to leach constituents. Effective for less-contaminated, untreated dredged material from Portland Harbor or for more contaminated dredged material that has been treated to an acceptable degree. Landfill acceptance of dredged material is determined on a case-by-case basis because permit requirements are facility-specific.	Does not accept RCRA hazardous waste. Requires overland transportation. Requires elimination of free liquids for both transport and disposal. May be less favored by agencies and the public, at least for some materials, because of proximity to metropolitan Portland.	Low	Yes	No
		Northern Wasco County	Adequate capacity. May be limited as to quantity of material that can be accepted. Effective for less-contaminated, untreated dredged material from Portland Harbor or for more contaminated dredged material that has been treated to an acceptable degree. Landfill acceptance of dredged material is determined on a case-by-case basis because permit requirements are facility-specific.	Does not accept RCRA hazardous waste. Requires overland transportation.	Low-Moderate	Yes	No
		Roosevelt Regional	Adequate capacity. Effective for less-contaminated, untreated dredged material from Portland Harbor or for more contaminated dredged material that has been treated to an acceptable degree. Landfill acceptance of dredged material is determined on a case-by-case basis because permit requirements are facility-specific.	Does not accept RCRA hazardous waste. Accepts wet waste. Rail transportation available if a transloading facility can be sited in Portland near the river. Differences between Hazardous Waste Regulations in Oregon and Dangerous Waste Regulations in Washington need to be considered. Farther from the Site than Hillsboro or Wasco County but transportation would be mostly by barge or rail.	Moderate	Yes	Yes
		Columbia Ridge (Subtitle D)	Adequate capacity. Effective for less-contaminated, untreated dredged material from Portland Harbor or for more contaminated dredged material that has been treated to an acceptable degree. Landfill acceptance of dredged material is determined on a case-by-case basis because permit requirements are facility-specific.	Does not accept RCRA hazardous waste. Accepts wet waste. Rail transportation available if a transloading facility can be sited in Portland near the river.	Moderate	Yes	No
Disposal		Chem Waste (Subtitle C)	Redundant containment and leachate collection systems and location in an area that receives little precipitation and is removed from shallowest groundwater all contribute to long-term effectiveness.	Accepts RCRA waste. Rail transport available if a transloading facility can be sited in Portland near the river.	High	Yes	Yes
	Confined Aquatic Disposal (CAD)	Columbia River (RM 102.5)	Demonstrated effectiveness in aquatic environment. Effective containment of metals, organics, and PCBs. Can be designed to include habitat enhancement for salmonids. CADs must be engineered to withstand bioturbation, advective flux, and release of buried COPCs, propeller and/or high-flow scour, and earthquakes. Requires long-term monitoring, institutional controls, and financial commitment.	High potential for increased releases during disposal. CAD cells may be implemented with solid phase controls, such as silt curtains or berms, in order to address concerns with potential sediment transport outside the CAD area during filling events. Need for seasonal capping reduces available capacity. Potential for additional actions if CAD fails. Requires concurrence with land owner.	Moderate	No See Table 2.4-3	

		Ross Island	Demonstrated effectiveness in aquatic environment. Effective containment of metals, organics, and PCBs. Can be designed to include habitat enhancement for salmonids. CADs must be engineered to withstand bioturbation, advective flux, and release of buried COPCs, propeller and/or high-flow scour, and earthquakes. Requires long-term monitoring, institutional controls, and financial commitment.	High potential for increased releases during disposal. CAD cells may be implemented with solid phase controls, such as silt curtains or berms, in order to address concerns with potential sediment transport outside the CAD area during filling events. Need for seasonal capping reduces available capacity. Potential for additional actions if CAD fails. Requires concurrence with land owner.	Moderate	No See Table 2.4-3	

	Confined Disposal Facility (CDF)	Terminal 4 Slip 1	Effective if constructed and maintained properly.	60% design complete. Large capacity. Requires long-term monitoring and maintenance. Requires flood rise analysis and mitigation. RCRA regulations exclude dredged material that is subject to the requirements of Section 404 of the Clean Water Act, which would govern disposal of sediment in a disposal area within the navigable waters of the United States, from the definition of hazardous waste. Waterway impacts such as disruption of circulation patterns, impact on flooding, need for low permeability subgrade formation, and avoidance of buried utilities. In addition, because of the permanent loss of aquatic habitat, extensive mitigation would be required.	High	Yes	Yes
		Swan Island Lagoon	Effective if constructed and maintained properly.	Large capacity. Requires long-term monitoring and maintenance. Requires flood rise analysis and mitigation. No proponent. RCRA regulations exclude dredged material that is subject to the requirements of Section 404 of the Clean Water Act, which would govern disposal of sediment in a disposal area within the navigable waters of the United States, from the definition of hazardous waste. Waterway impacts such as disruption of circulation patterns, impact on flooding, need for low permeability subgrade formation, and avoidance of buried utilities. In addition, because of the permanent loss of aquatic habitat, extensive mitigation would be required.	High-Very High	No See Table 2.4-3	
		Arkema	May not be effective due to high levels of contamination offshore of Arkema and presences of uneven bedrock surface.	Limited capacity. Requires long-term monitoring and maintenance. Construction adjacent to active river channel may result in unacceptable flood rise. RCRA regulations exclude dredged material that is subject to the requirements of Section 404 of the Clean Water Act, which would govern disposal of sediment in a disposal area within the navigable waters of the United States, from the definition of hazardous waste. Waterway impacts such as disruption of circulation patterns, impact on flooding, need for low permeability subgrade formation, and avoidance of buried utilities. In addition, because of the permanent loss of aquatic habitat, extensive mitigation would be required.	Very High	No See Table 2.4-3	
Ex-Situ Treatment	Physical	Particle Separation	Effective in reducing volume of highly contaminated material with high sand content. Increases effectiveness of dewatering dredged material. Not effective with sediments containing high concentration material with high organic content.	Readily implementable - mobile units available for quick setup and takedown time. Can be combined with soil washing to improve separation. Clean separated sand may be available for potential beneficial use (would require identification of reuse). Separation technologies available and have been used in several programs of similar size and scope. Bench scale testing to characterize the different size or density fractions is typically needed to assess feasibility.	Low	Yes	No
		Cement Solidification/ Stabilization	Bench-scale studies have added immobilizing reagents ranging from Portland cement to lime cement, kiln dust, pozzolan, and proprietary reagents. Lime has been successfully added to dredged material at other projects.	BMPs are necessary to ensure air quality impacts are minimized. Dewatering prior to cement stabilization/solidification is dependent on logistics. Mechanically dredged sediments will be saturated, but since the volumes of water produced by mechanical dredging are much more limited, blending with stabilizing agents can be done in barges on wet materials. Where hydration of the blending agent is required, some water would actually be desirable. A similar operation could be performed on hydraulically dredged sediments after they have become sufficiently dewatered (passively) to permit handling, or after they were mechanically dewatered.	Low-Moderate	Yes	No
Ex-Situ Treatment		Sorbent Clay Solidification/ Stabilization	Allows adsorption of organic contaminants on to clay. Not good for volatile or flammable organics, due to vapor emission and fire concerns. Factors that influence the performance of S/S include: (1) interfering agents which prevent proper set or curing, including organics (oils, grease, phenols, chlorinated solvents) and inorganics (sulfate, phosphate); (2) gas emissions - since generally exothermic reactions, heat is generated and some volatilization of toxics can occur; and (3) final strength - decreased by organics.	BMPs are necessary to ensure air quality impacts are minimized. Lime amendment for pH control to allow for adsorption of organic contaminants	Moderate	Yes	No

	Biological	Land Farming/Composting	Limited to TPH and PAHs. Not effective for metals, PCBs, dioxin or TBT. PAHs and some SVOCs are amenable to aerobic degradation.	Large staging areas are required within close proximity to the project. BMPs may be necessary to ensure air quality impacts are minimized. If air quality impacts are expected, a contained biological PO may be more appropriate. BMPs are also necessary to control contaminant migration from runoff. Bench-scale testing would be required during design. Requires dewatering of dredged material.	Low-Moderate	No	

		Biopiles	Limited to VOCs, SVOCs, PAHs and TPH. Not effective for metals, PCBs, TBT, or dioxins. The presence of site COCs such as PCBs, organochlorine pesticides and metals may prevent these technologies from achieving the desired cleanup levels.	Large treatment areas are required. Regular equipment maintenance is required. BMPs are necessary to ensure air quality impacts are minimized. Bench-scale testing would be required during design. Requires dewatering of dredged material.	Low-Moderate	No	
		Fungal Biodegradation	Not effective for metals, PCBs, dioxins or TBT. High concentrations of contaminants may inhibit growth.	The technology has been tested only at bench scale. No known full-scale applications.	Low-Moderate	No	
	Biological	Slurry-phase Treatment	Not effective for metals, PCBs, dioxin or TBT. PAHs and some SVOCs are amenable to aerobic degradation.	Large volume of tankage required. No known full-scale applications.	Low-Moderate	No	
		Enhanced Biodegradation	Not effective for metals, PCBs, dioxin or TBT. PAHs and some SVOCs are amenable to aerobic degradation.		Moderate	No	
	Chemical	Solvent Extraction	Successfully pilot-demonstrated at New Bedford Harbor which is contaminated with PCBs. Where metals and organics are both present in the sediment, which is typical, chemical extraction targeting organics would likely need to be coupled with other operations addressing removal/stabilization of metals. This demonstration has limited applicability to the Portland Harbor project as the goal of the pilot program was to reduce PCB concentrations to below 50 mg/kg to reduce the waste code from Subtitle C to Subtitle D; therefore, there are limited data available to determine the effectiveness of the pilot in treating to lower concentrations.	Regular equipment maintenance is required. BMPs are necessary to ensure air quality impacts are minimized. Process water and residual wastes require treatment and disposal, which could significantly increase the overall cost of treatment. Bench-scale testing would be required during design.	High	No	
	Thermal	Incineration	High temperatures result in generally complete decomposition of PCBs and other organic chemicals. Effective across wide range of sediment characteristics. Not effective for metals.	Requires air pollution control device. Mobile treatment may be used, if available, and may be more cost effective than offsite thermal treatment if the treatment volumes are high enough. Nearest existing, permitted facility is greater than 500 miles from project. High energy consumption. Potential for dioxin generation is a concern. Public concern may make implementability challenging.	Very High	No	
		High Temperature Thermal Desorption	Target contaminants are SVOCs, PAHs, PCBs, TBT, and pesticides. Metals are not destroyed. Especially effective with high levels of PCBs (>50 ppm).	Requires air pollution control device. Technology readily available as mobile units that would need to be set up at a fixed location in lose proximity to the contaminated sediments. High energy consumption; however, costs may be offset through the sale/use of generated power. Pre-permitting consultation and acceptance of BU products is crucial to economic viability of PO.	High	No	
		Low Temperature Thermal Desorption	Effective for SVOCs and PAHs. May have limited effectiveness for PCBs. Metals not destroyed. Effectiveness demonstrated at other sediment remediation sites. Fine-grained sediment and high moisture content will increase retention times. Widely-available commercial technology for both on-site and off-site applications. Acid scrubber will be added to treat off-gas.	Requires air pollution control device. Fine-grained sediment and high moisture content will increase retention times. Vaporized organic contaminants that are captured and condensed need to be destroyed by another technology. The resulting water stream from the condensation process may require further treatment. Widely-available commercial technology for both on-site and off-site applications.	Low	Yes	Yes
		Vitrification	Thermally treats PCBs, SVOCs, TBT, and stabilizes metals. Successful bench-scale application to treating contaminated sediments in Lower Fox River, and in Passaic River.	Not commercially available or applied on similar site and scale.	Moderate-High	No	